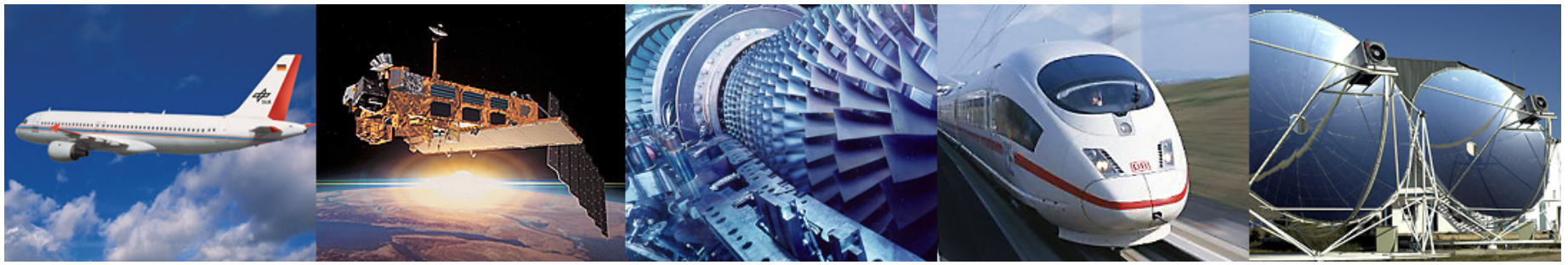
Contributions of REELCOOP to Concentrating Solar Power (CSP) and Solar Process Heat

German Aerospace Center (DLR)
Institute of Solar Research
Dirk Krüger

German Aerospace Center (DLR)



- Research Institution, Space Agency and Project Management Agency
- Research Areas:

  Aeronautics | Space Research and Technology | Transport | Energy | Defence and Security

- 8000 employees across 33 institutes and facilities at 16 sites in Germany
- 17 subsidiaries, co-operations and outposts in Germany, the Netherlands and Spain
- Offices in Brussels, Paris, Tokyo and Washington
- Total income 2015: €891 Mio. (about 9% for Energy Research)

Institute of Solar Research

Directors

Prof. Dr. Robert Pitz-Paal/ Prof. Dr. Bernhard Hoffschmidt

Point-Focus Systems
Dr. Reiner Buck (34 P)

Line-Focus Systems
K. Hennecke (16 P)

Qualification
Dr. P. Heller (33 P)

Solar Chemical Engineering
Dr. C. Sattler (24 P)

Facilities and Solar Materials
Dr. K.-H. Funken (20 P)

Institute of Solar Research

160 employees at 4 sites

Partners in Part P3 of REELCOOP

Ecole Nationale d'Ingénieurs de Tunis

Alternative Energgy Technologies, Sousse

Zuccato Energia, Verona, Italy

Soltigua, Cesenatico, Italy

Ciemat, Madrid-Almeria, Spain

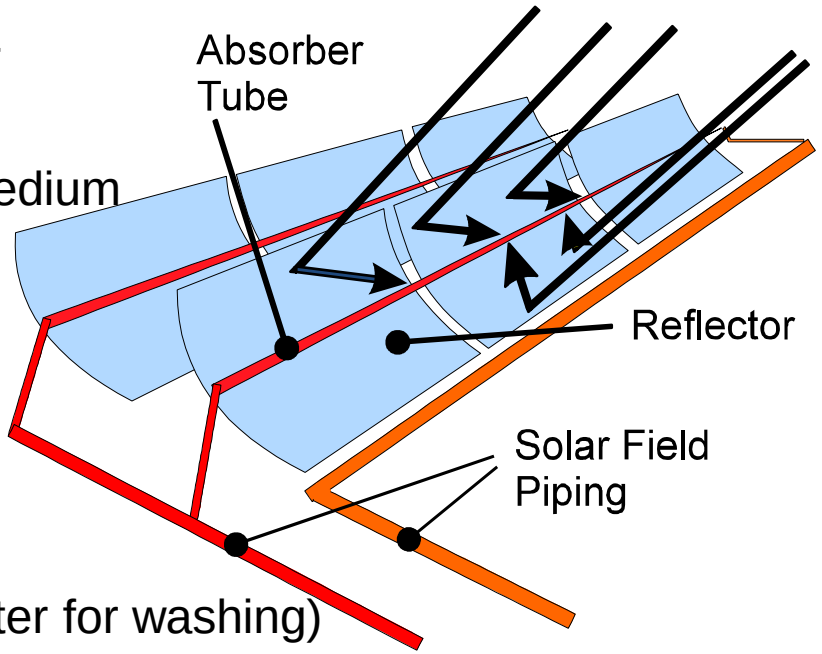
University of Porto, Portugal

German Aerospace Center, Cologne, Germany

Introduction to Concentrated Solar Power (CSP)

How does it work?

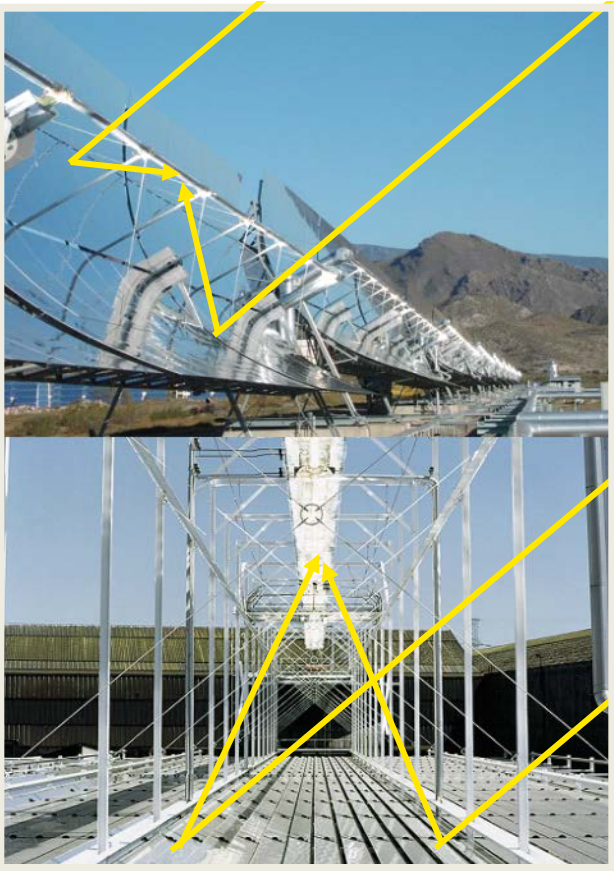
- Sunrays meet a reflector
- Reflector concentrates light onto absorber
- Absorber gets hot
- Heat is directly used or transferred to a medium
  - Water
  - Thermal oil
  - Molten salt
  - Air, particles, others
- Medium is able to be transported
- Medium is able to be stored
- Medium can be directly used (e.g. Hot water for washing)
- Medium can drive a turbine or motor to produce electricity or heat



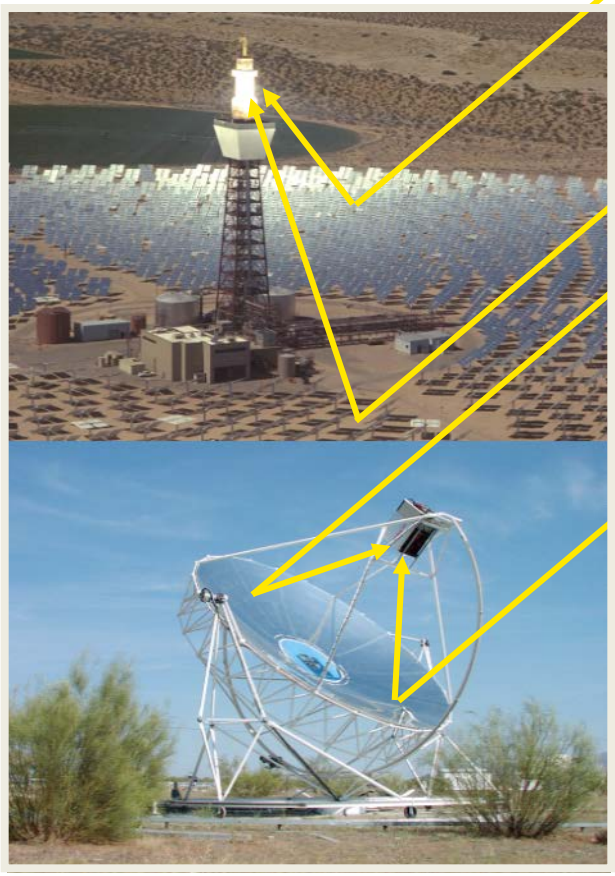
Introduction to CSP

How does it work?

Parabolic Trough (Foto DLR)



Solar Tower (Foto SNL)



Up to 550 °C Steam Turbines

Up to 1000 °C Gas Turbines, Motors

Linear Fresnel (Foto MAN/SPG)

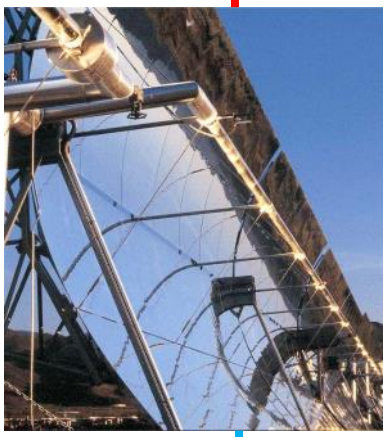
Dish-Stirling (Foto SBP)

Possible applications

Solar collector

back up boiler

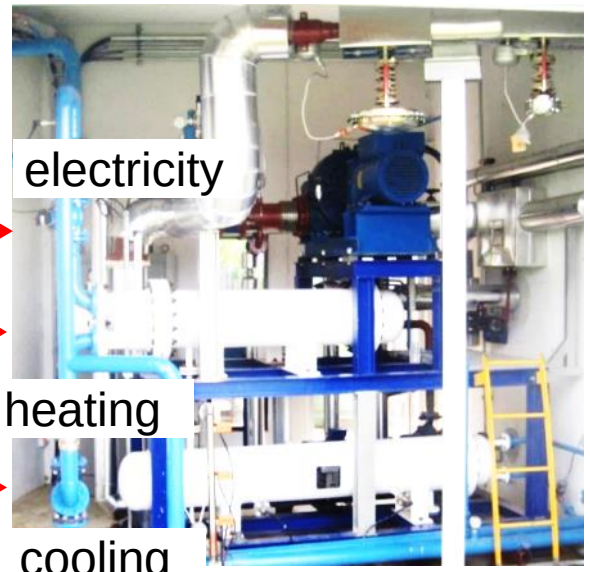
storage



electricity

heating

cooling

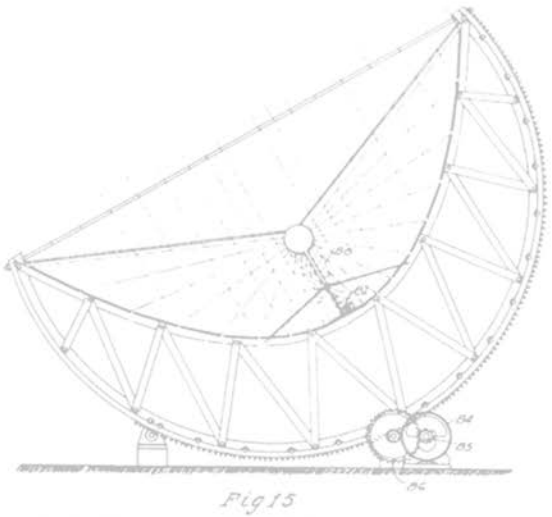


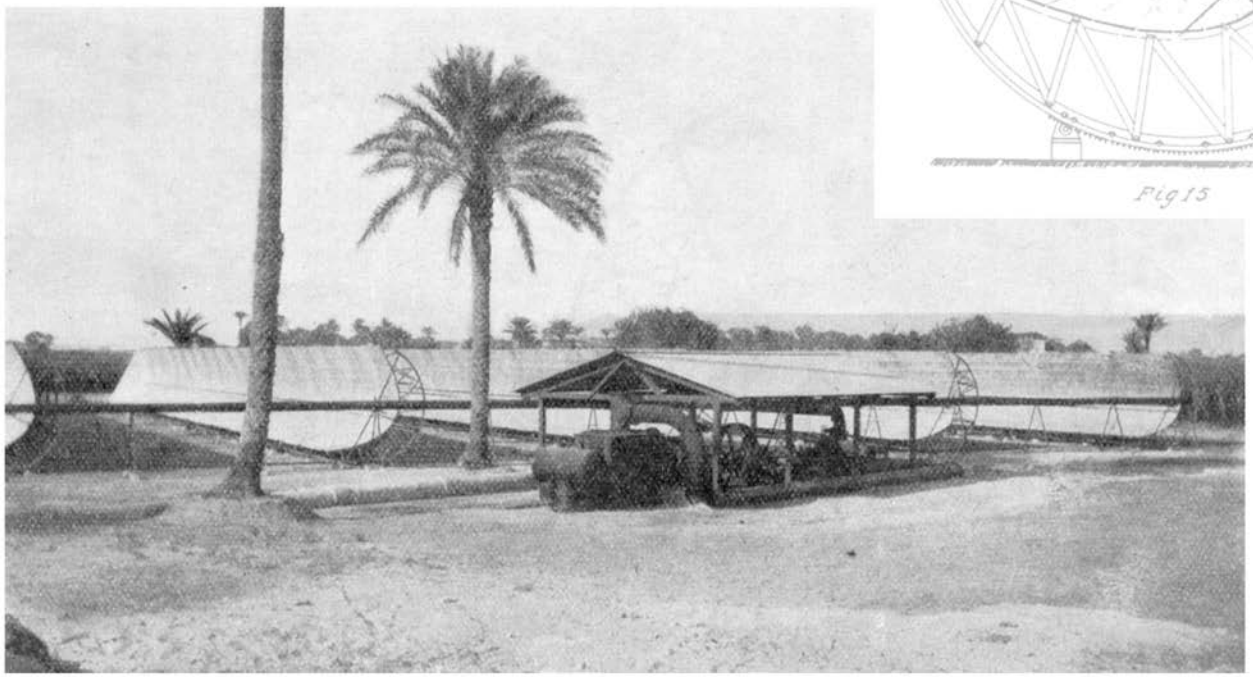
Seawater desalination

History of CSP

first parabolic trough collectors:

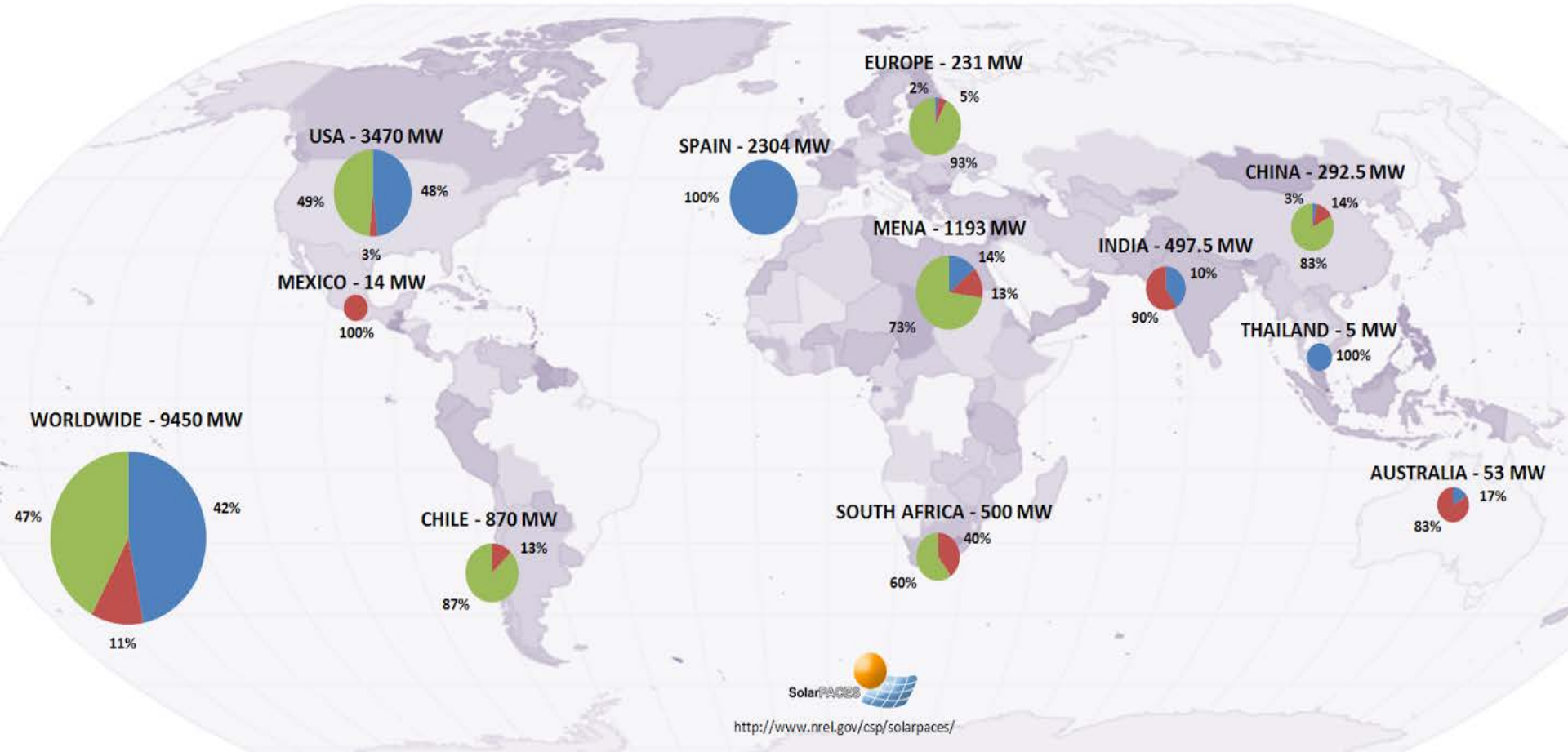
- construction in 1912 in Egypt (Meadi)
- saturated steam at 1 bar
- steam motor connected to a water pump (380 l/s)





CSP plants worldwide

CSP plants operational (blue), under construction (red) and in development (green)



Commercial Parabolic Trough Technology NOOR 1 Ouarzazate, Morocco

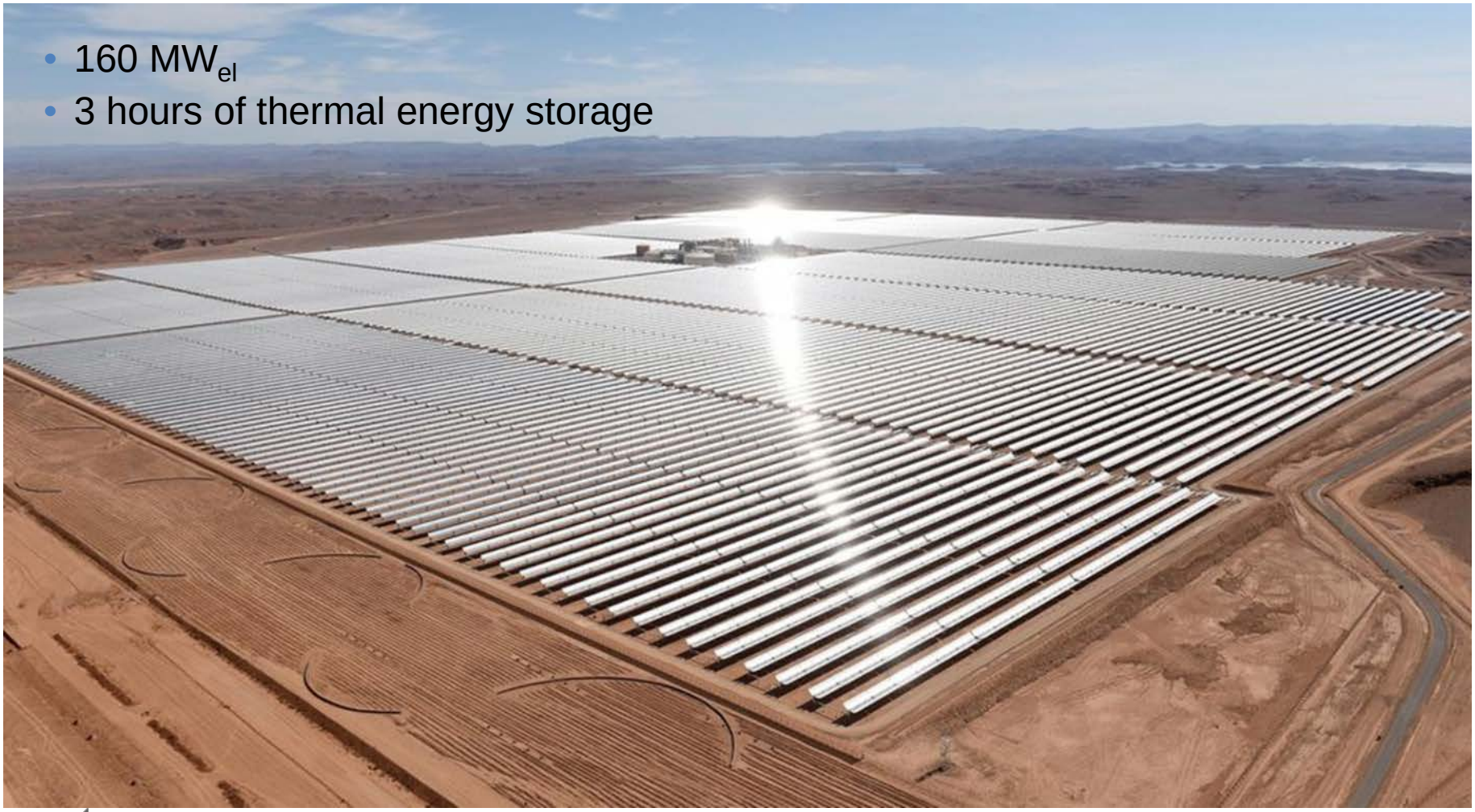
The Moroccan solar plan foresees 2000 MW_{el} of solar power

Installation	Max. Power (MW)	Type	Start operation
1	160	Parabolic Trough Plant	February 2016
2	200	Parabolic Trough Plant	in construction
3	160	Solar Tower Plant	in construction
4	50	PV Plant	in planning

Further plants currently: Combination of CSP with 4h storage and PV

Commercial Parabolic Trough Technology
NOOR 1 Ouarzazate, Morocco

- 160 MW_{el}
- 3 hours of thermal energy storage



Commercial Parabolic Trough Technology
TSE1, Kanchanaburi, Thailand

- Direct Steam Generation (DSG)
- 330 °C / 30 bar
- 5 MW_{el}

Solar Process Heat
RAM-Pharma, Amman, Jordan

- Direct steam generation in Fresnel collector field (394 m²)
- Start of operation: March 2015
- 160 °C

Small scale solar power REELCOOP ENIT, Tunis,

ENERMENA Project at ENIT and other institutions in Tunisia and MENA region

Teaching material for concentrating solar thermal technologies

See DLR Webpage for more information:
www.dlr.de/enermena

During the last years, the market for CSP technologies showed a rapid growth after several years of standstill. This growth is mainly driven by new solar power plants in markets like China, India, Southafrica and the countries of the MENA region.

The MENA region has a huge potential for the implementation of such technology due to its excellent solar resource conditions. The enerMENA project takes essential steps to prepare the ground towards a sustainable realization of CSP power plants in the MENA region.

Funded by the German Federal Foreign Office, the project was initiated and is run by the Institute of Solar Research at the German Aerospace Center (DLR), a pioneer in the field of CSP technology.

The aim of enerMENA is to provide knowledge and practical experience to CSP specialists and stakeholders in the MENA region. By this it contributes both to the optimization of the construction and the operation of solar thermal power plants.

It includes R&D activities to develop efficiency improvement measures and offers professional training courses for different target groups. With it's wide training program enerMENA adresses engineers and technicians working on site as well as researchers, University professors and students in the partner countries.

The German Aerospace Center (DLR) works jointly with over 45 partners from Egypt, Algeria, Morocco, Tunisia and Jordan to realize the objectives of the enerMENA project. Among partners are engineers, skilled workers, and decision makers at energy centers, national energy agencies, universities, engineering companies and related ministries.

A network of CSP professionals and specialists is being established and supported in the framework of the project to coordinate future activities.

The enerMENA project consists of three different modules:


The enerMENA course program adresses CSP specialists and stakeholders, professionals and students. Source: DLR


Reflectivity Measurement Training on Site. Source: DLR


Photogrammetry Training on Site. Source: DLR

- enerMENA Partners
- enerMENA Capacity Building Program
- enerMENA Meteo-Network
- CSP Technology Support for enerMENA Partner Countries

enerMENA News

- News
- News Archive

CSP Links

- Protermo Solar
- solarPACES
- DUN Desertec University Network

Reelcoop project demonstrates technologies

Demonstration of technologies:
Solar collector
ORC turbine
Biogas production and boiler
Thermal storage

Impact for Tunsisian companies:
Understanding technologies and their operation by “hands on”
Hybrid combination of solar and biomass for operating turbine
=> Eases decision on entering the technologies and market

Reelcoop project demonstrates local share

Local products/work:

- Piping and welding work
- Foundations
- Fencing
- Electrics
- Plant control
- Steam system components

Local share generally roughly 30% in process heat when collectors are imported

Higher with local solar collector production

Local share depends also on availability of products and specialised personnel

Experiences of personnel involved in Reelcoop project

Personell especially at ENIT and AES as well as other Reelcoop partners gained experiences during installation

Personnel at ENIT and project partners will gain experiences in operating the solar field, turbine, cooler, steam cycle, measurement technology, data analysis, safety issues etc.

Training of personnel in Reelcoop installation

Make installation available for other institutions, universities, use as „laboratory“

Formation of personnel by visits, joint operation through training courses, thesises

Formation in the fields of operating the solar field, optics of solar concentrators, turbine, cooler, steam cycle, control software, measurement technology, data analysis, safety issues etc.

Impact REELCOOP
Production in Tunisia of Sheffler Dishes

Company founded by former DLR scientist:

Wee (water energy & environment)

Demonstration of solar cooking at Eminem youth house

Conclusions

CSP and solar process heat will play a significant role in the future energy market

Solar process heat and CSP can play an important role in Tunisia

The installation at ENIT is a significant milestone to prepare CSP activities by training of personnel

Thank you for your attention

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